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National Aeronautics and Space Administration
George C. Marshall Space Flight Center
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Contract: NAS8-35594

Subject: Monthly Progress Report--Development of a Global Model for Atmospheric Backscatter at CO_2 Wavelengths

Period: May 14 - June 13, 1984

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Technical Monitor, NAS8-35594

Introduction

Work has continued on the tasks shown below.

Task 1.2 To investigate the effect of aerosol microphysical processes occurring in an aerosol plume which undergoes transport in the atmosphere, on its β_{CO_2} value.

In the previous Monthly Progress Report (May 21, 1984), we discussed the simulated variations of aerosol size distribution in a particular layer (centered at z = 4 km) due to gravitational sedimentation effects. For the purpose of examining the simulated results of the entire 10 layers in detail, graphic's software has been developed. This software is able to display the time evolution of the aerosol size distribution parameters, including number concentration (N), mode radius (r_m), and the geometric standard derivation (σ). Figures 1 to 3 show the time variations of the vertical profiles of N, r_m, and σ, respectively. In these figures, only the results of every other time step are shown. They are given sequentially by the symbols ● , ■ , ◆ , ▲ , ◣ , and ☗. As described in the last report, the initial condition (given as ●) is featured by a dust layer located between 1 and 4 km. Above 4 km, there is a background atmosphere with a relatively small density of aerosol particles. In the lowest layer, the aerosol is also specified as the background condition appropriate to that level. Figure 1 shows clearly an increase in number concentration in the bottom layer and a decrease in the upper two dust model layers as the time increases. Not much change is found in the lowest part of the dust layer (the second model layer from the bottom). This feature reflects the nearly balanced condition between the influx of aerosols from the top and the outflux of aerosol from the bottom of this particular layer due to gravitational sedimentation. Above an altitude of 4 km,

the concentration is essentially steady with respect to the time steps.

Illustrating the time variation of model radius profile due to gravitational sedimentation, Fig. 2 shows a shift of the model radius toward the smaller particle size in the upper part of the dust layer ($2. < z < 4.$ km), and also a shift toward the larger size in the bottom layer. The shift of the model radius to smaller size in the lower part of the dust layer ($1. < z < 2.$ km) is also noticeable. In Fig. 3, distinct changes in σ are again found in the dust layer ($1. < z < 4.$ km) and in the lowest layer. As discussed before (Monthly Progress Report, March 21, 1984), gravitational sedimentation more effectively removes large particles than small particles. Thus, it is anticipated that the value of σ will be reduced due to sedimentation processes. This feature is clearly evident in the dust layer as shown in Fig. 3. It is interesting to note that Fig. 3 also shows that, at the bottom layer, σ first increases at the first two time steps and then decreases afterward. This indicates the incoming large particles from the dust layer above during the first two time steps. In conclusion, the current 10-layer model is capable of describing adequately the effect of gravitational sedimentation on the aerosol particle size distribution.

Task 2.1 Use of the SAGE/SAM II Data Set

Work has continued on the study of the SAGE/SAM II data set. Eighteen months of SAGE data have been processed, although these have not yet been fully examined. Seasonal variations in the tropospheric aerosol extinction are apparent. Examples of these are presented in Figs. 4, 5, and 6, which show the latitude variation in aerosol extinction for Spring 1979, Fall 1979, and Spring 1980. The similarity in the latitudinal characteristics for Spring 1979 and Spring 1980 (Figs. 4 and 6), is clear, as is the difference between the latitude variation in these two figures and that shown in Fig. 5 for Fall 1979.

The program for reading and processing the SAM II data has been completed and the data set for Spring 1979 studied. The values for aerosol extinction, obtained within the polar regions, agree well with those for the neighboring latitude bands, as measured by SAGE.

Work on the aerosol probability distribution has continued. Now that a global set of these probability distributions is available, it is possible to identify certain universal features. The study of these is continuing, particularly with a view to interpreting the variations in shape of the probability curves. The results of this study will be presented in a future report.

Dr. D. E. Fitzjarrald
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Research Schedule for Next Month

1. To continue work on the multi-layer numerical model described under Task 1.2.

2. To continue work on the SAGE/SAM II data set:

   a. Process and examine a further year of SAGE data.

   b. Process at least one year of SAM II data.

   c. Continue work on the analysis of the extinction probability distributions.

Remarks

No problems encountered.

G. S. Kent

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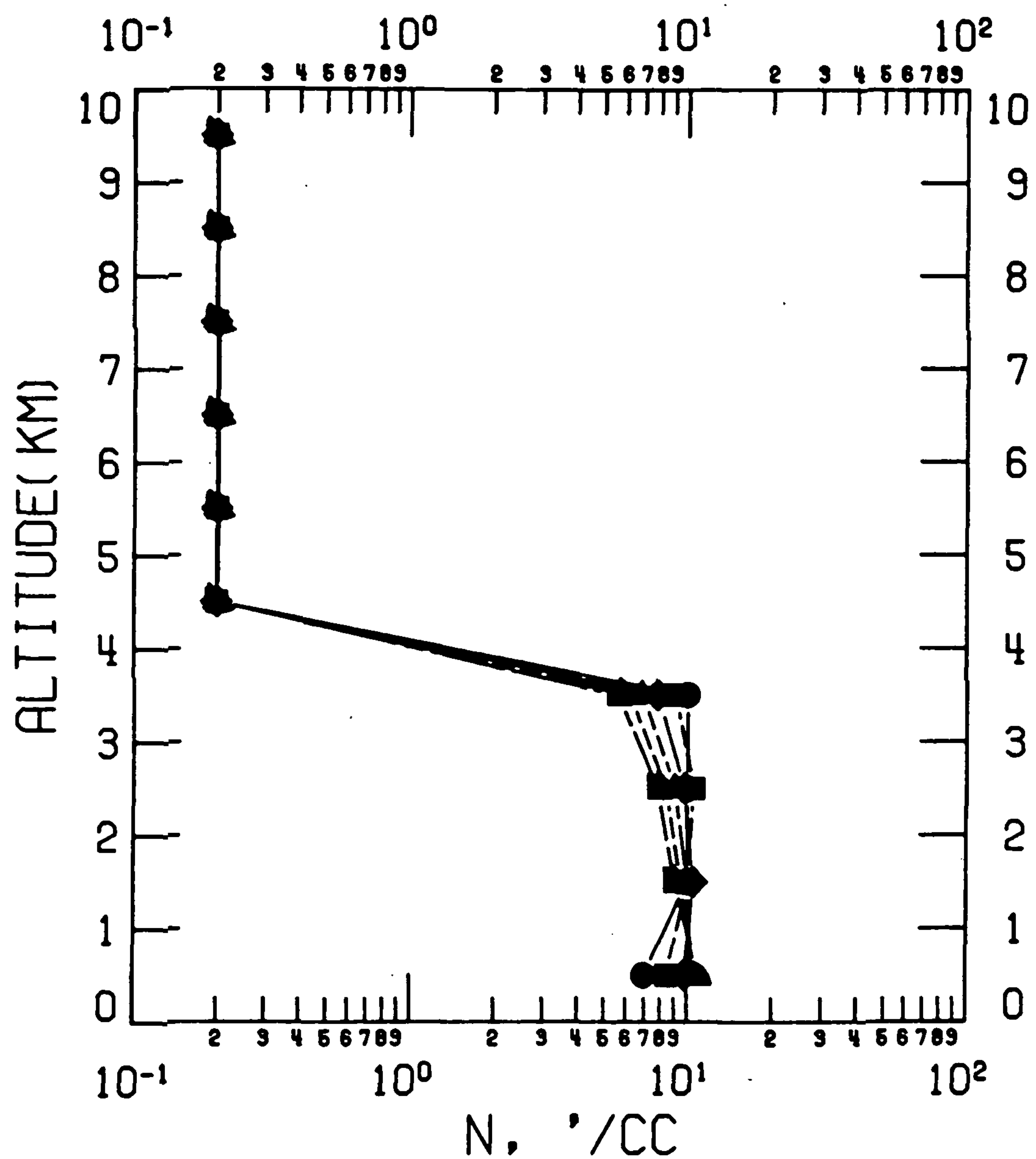

Figure 1. Time step results of aerosol particle concentration (No./cc). Only the results of every other time step are shown. They are given sequentially by symbols ●, ■, ◆, ▲, ◣, and ◣. The time increment is 2 days.

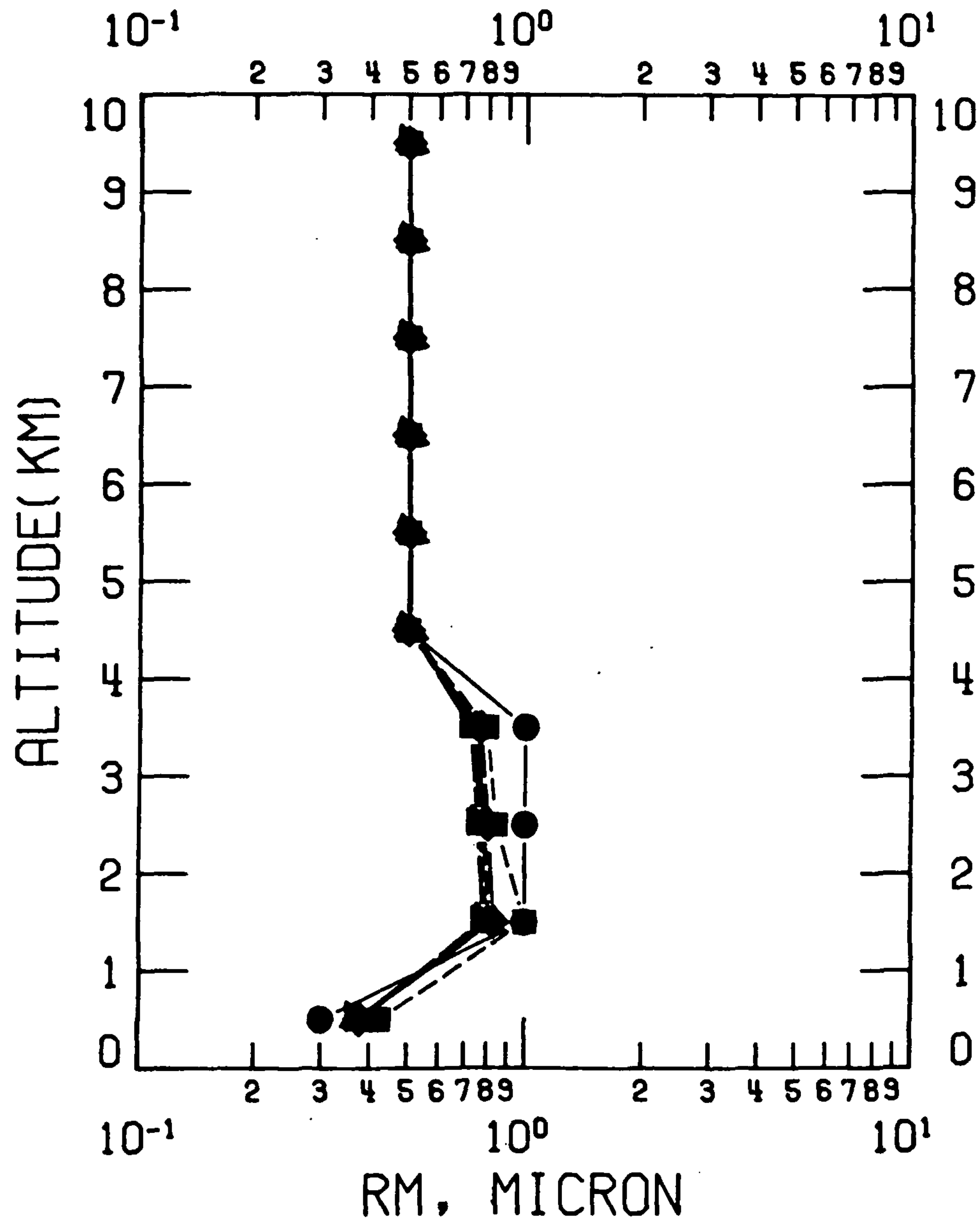

Figure 2. The same as Figure 1, except for mode radius (r_m, in micron).

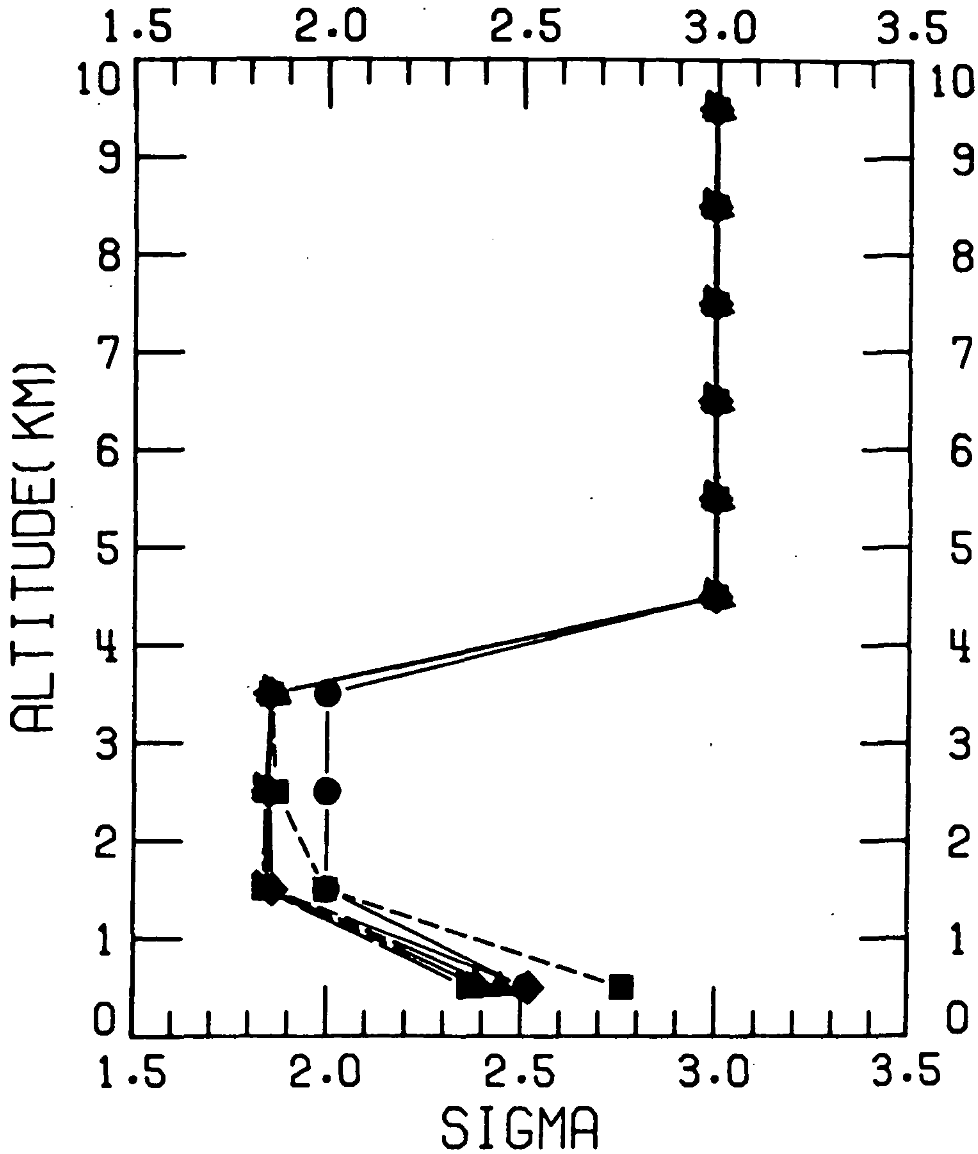

Figure 3. The same as Figure 1, except for the geometric standard deviation σ.

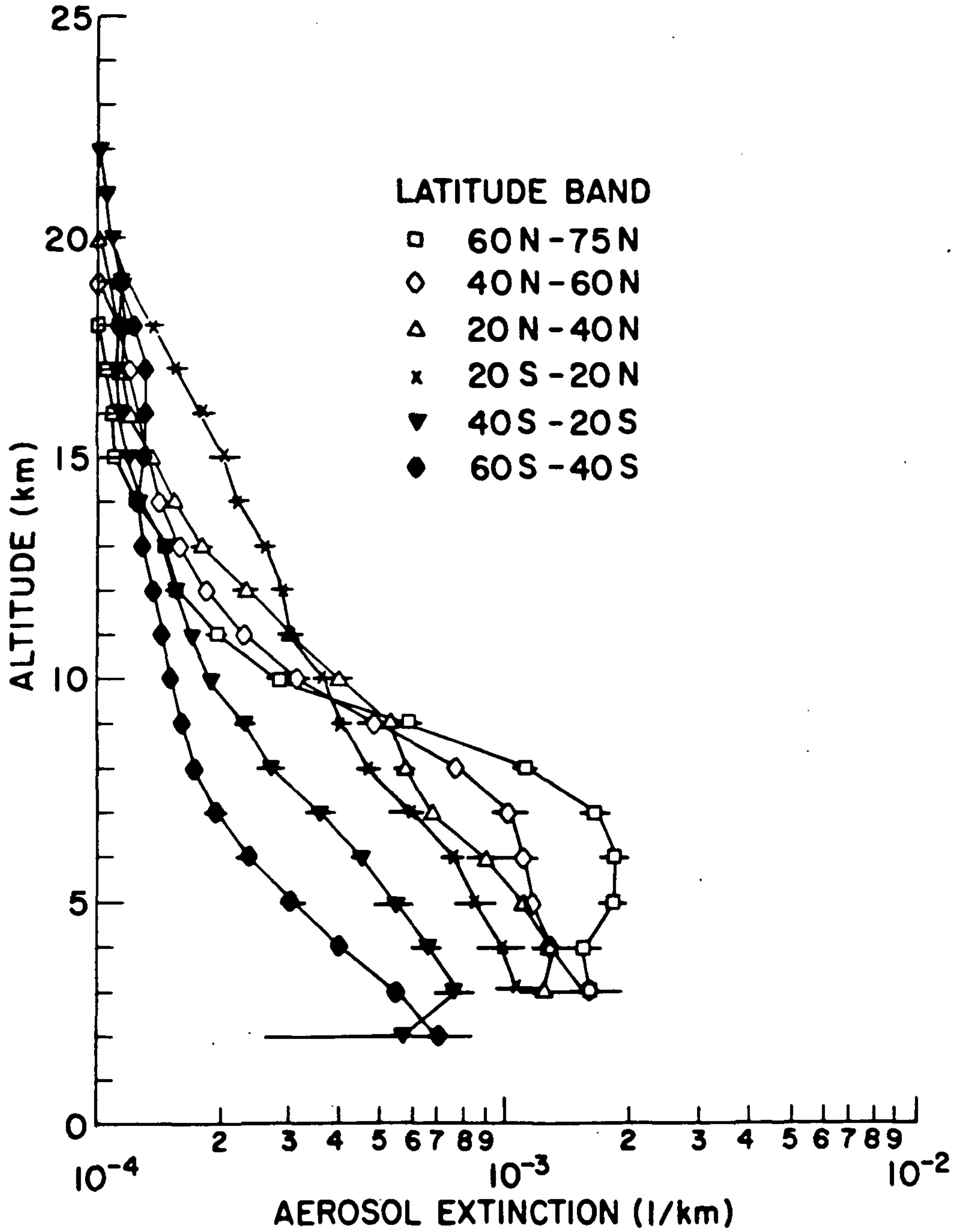

Figure 4. SAGE Aerosol Comparison (March-May, 1979).

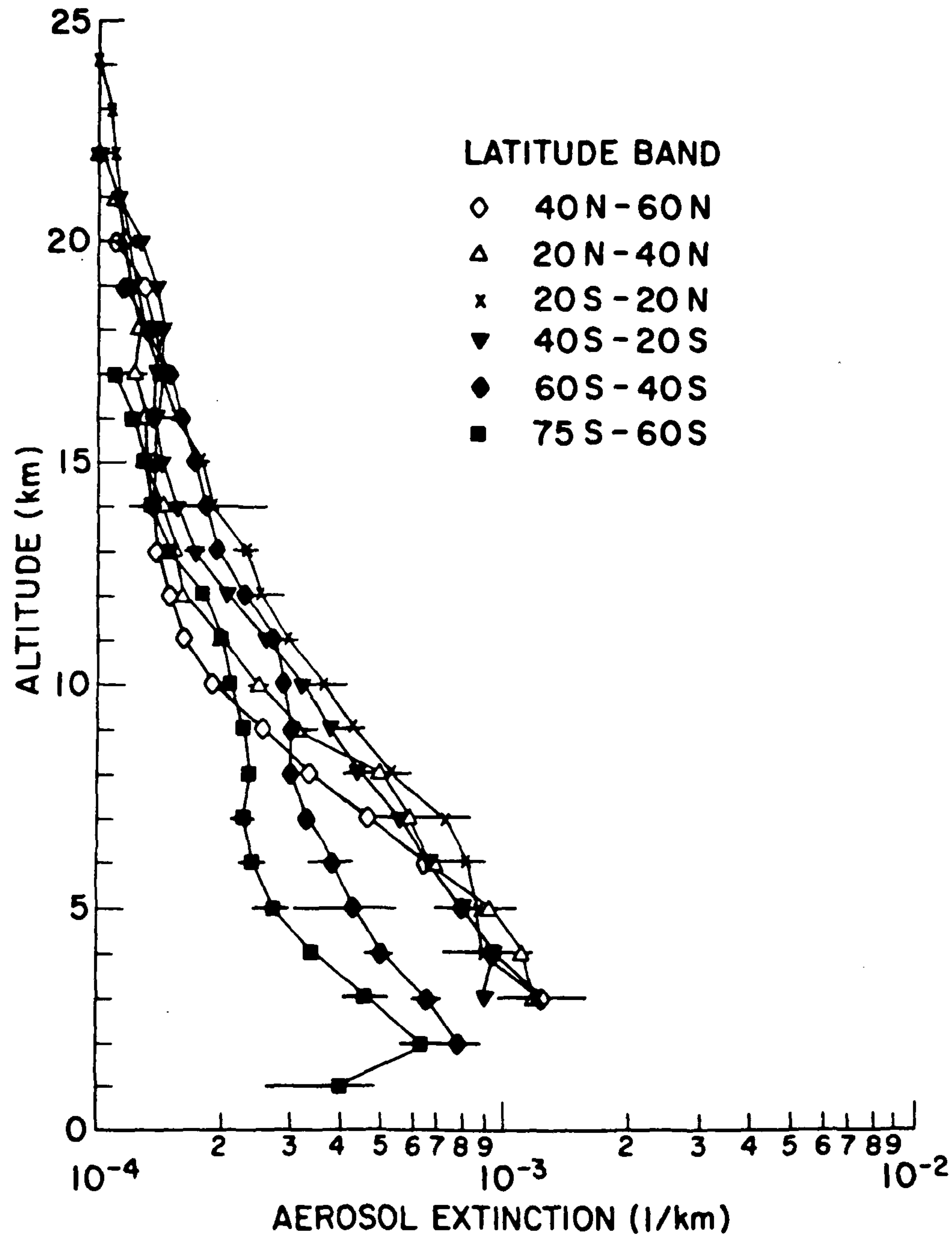

Figure 5. SAGE Aerosol Comparison (September-November, 1979).

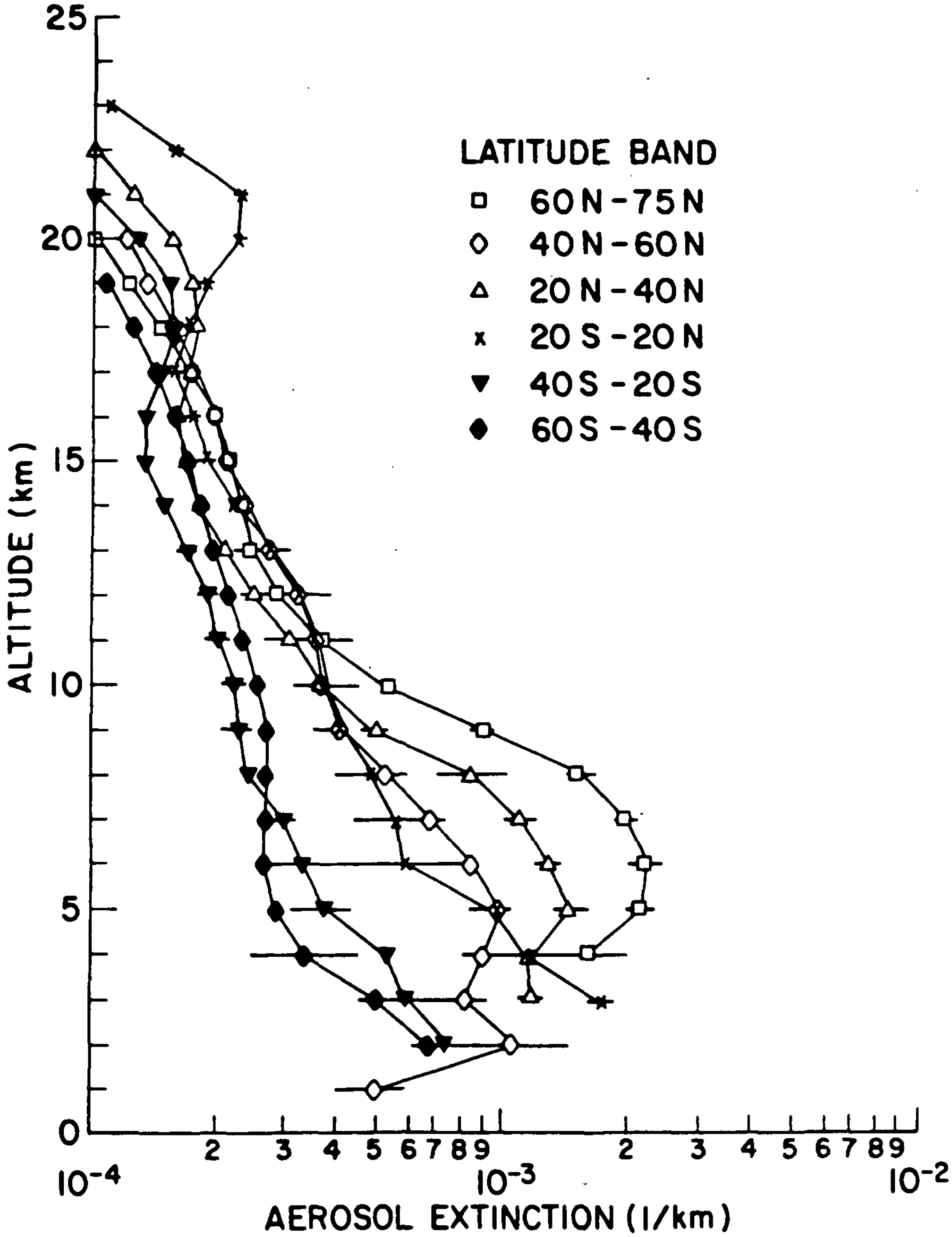

Figure 6. SAGE Aerosol Comparison (March-May, 1980).